

# **Fisheries Report 03 - 06**

## **SURVEY OF THE TROUT FISHERY IN THE SOUTH FORK OF THE HOLSTON RIVER, March – October 2002**



**A Final Report Submitted To  
Tennessee Wildlife Resources Agency**

**By**

**Phillip W. Bettoli, Ph.D.**

**U.S. Geological Survey  
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## *Executive Summary*

1. The fishery in the South Fork of the Holston river was investigated between March and October 2002 using a roving creel survey. The river was last surveyed in 1997. In 2002 the river was stocked with 17,500 catchable ( $\geq 175$  mm total length) brown trout, 39,410 catchable rainbow trout, and 139,385 fingerling rainbow trout.
2. Fishing pressure over the 8-month survey totaled 48,190 h (90% confidence interval,  $\pm 6,282$ ). Fishing pressure over similar eight-month periods was 52% lower in 2002 than in 1997. Anglers took an estimated 17,782 trips to the river during the 2002 survey, or 39% fewer than in the 1997 survey (29,028 trips).
3. The catch rate for trout in 2002 was high, averaging 1.71 fish/h, or 54% higher than in 1997 (1.11 fish/h). The harvest rate was low (0.32 fish/h).
4. The estimated catch of rainbow trout was 66,800 fish. The number of rainbow trout harvested in the 2002 survey (15,627) was 13% of the total number caught.
5. The number of brown trout harvested (1,031 fish) was 8% of the number reportedly caught (13,565 fish) during the 2002 survey.
6. The number of trout harvested by anglers who had completed fishing when interviewed averaged 0.81 (SE = 0.12) trout per trip. Those same anglers reported catching an average of 5.88 (SE = 0.64) trout per trip.
7. In the 2002 survey, out-of-state residents represented 37% of all interviewed anglers, compared to 30% in 1997. Most of the out-of-state anglers were Virginia residents (28% of all anglers interviewed). North Carolina residents represented 5% of all anglers interviewed, and the remaining out-of-state anglers came from 14 other states. Residents of Sullivan County accounted for 54% of all the anglers interviewed and 84% of the Tennessee residents who fished the river.
8. In 1997, 62% of the anglers interviewed were fishing with some form of bait; that percentage rose to 74% in 2002. Flyfishing gear was used by 21% of the anglers interviewed in 2002 (the 1997 survey did not distinguish between anglers using spinning gear and flyfishing gear).
9. No empirical data exist to explain the substantial drop in fishing pressure on the South Fork of the Holston River in 2002 compared to the 1997 survey, nor the concomitant increase in pressure on the nearby Watauga River. Although possible explanations abound, it is not clear which explain the shifting pattern of angler use on those two east Tennessee tailwaters.

## INTRODUCTION

The Tennessee Wildlife Resources Agency (TWRA) intensively manages the trout fishery in the South Fork of the Holston River in east Tennessee. Between March and October 2002, a roving creel survey was used to examine fishing pressure and harvest rates by trout anglers fishing the river. Characteristics of the anglers using the resource for that 8-month period were also examined. The tailwater was last surveyed by the Tennessee Valley Authority in 1997 and those results were reported by Bettoli et al. (1999).

## STUDY AREA

The South Holston Dam is located at South Fork of the Holston River km 80.1 in Sullivan County, Tennessee, about 10 km southeast of Bristol, TN-VA. The 22-km long area managed for trout is bounded upstream by the South Holston Dam and downstream by the headwaters of Boone Reservoir (Bivens et al. 1996). South Holston Dam was constructed by the Tennessee Valley Authority (TVA) for flood control, power generation, and other related benefits.

South Holston Dam was closed in November 1950, followed by power generation in February 1951. The dam has a maximum height of 87 m and a length of 488 m (Davis and Brock 1994). The water intake is located at an elevation of 488 m msl, 39 m below the surface at full pool. Water may be released through the turbine, sluiceway, or spill gates. The dam has one generating turbine with a maximum capacity of 38,500 kW and a mean discharge of 68 m<sup>3</sup>/s (Davis and Brock 1994). A base flow of 2.5 m<sup>3</sup>/s is maintained by an aerating labyrinth weir, which was constructed in 1991 about 2 km downstream of the dam (Scott et al. 1996). The weir pool is maintained with twice-daily 40-min pulses of water from South Holston Dam during periods of non-generation.

During periods of generation the river is approximately 1.5 m - 2.0 m deep, 61 m wide, and covers about 133 ha (Bivens et al. 1996). At base flow the river averages 0.5 m deep, 40 m across, and has a surface area of 88 ha. The pool-to-riffle ratio at base flow is 1: 2 and the percent by area of riffle, pool, and run habitats is 43 percent, 32 percent

and 25 percent, respectively (Bettoli et al. 1999). The river has a gradient of 1.5 m/km between the dam and the headwaters of Boone Reservoir.

The number of trout stocked into the South Fork of the Holston River by the Tennessee Wildlife Resources Agency varies from year to year. In 2002, TWRA stocked catchable (> 200 mm total length) rainbow trout Oncorhynchus mykiss (n = 39,410), fingerling rainbow trout (n = 139,385), and catchable (> 170 mm TL) brown trout Salmo trutta (n = 17,500). Substantial natural reproduction by trout also occurs in the South Fork of the Holston River (Bettoli et al. 1999).

The trout fishery in the South Fork of the Holston River is currently managed with a protected slot limit. No trout between 406 mm and 559 mm total length (16 – 22 inches) may be possessed and only one trout of the daily 7-fish creel may exceed 559 mm. The river also contains two spawning refuge areas; in two river reaches fishing is prohibited between November 1 and January 31 to protect spawning aggregations of trout and their redds.

## METHODS

A stratified, uniform probability roving creel survey was conducted between March 1 and October 31, 2002. The survey was designed to collect information about the amount of fishing pressure the tailwater was receiving, the catch and harvest rates of rainbow trout and brown trout, and the catch per unit of effort by anglers. The sample design was modeled closely after the survey design used by TVA to monitor fishing pressure on the South Fork of the Holston River between the late 1980s and 1997; the present survey followed the same general design employed by TVA in the 1997 survey.

The survey was stratified by month and kind-of-day. An average of nine weekdays and six weekend days were surveyed each month. Sampling days were divided into equal work periods based on sunrise and sunset times with equal probabilities of sampling the AM or PM work shifts. The clerk counted anglers on the river once each work shift. The time to start the count was randomly selected from a list of possible start times for each shift, beginning at daylight (or midday) and every 30 minutes thereafter until 1 h before the end of the shift. The counts were adjusted

upwards when more boat/raft trailers were counted than boats by assuming two anglers per boat for each boat that was presumed to be on the river, but was not observed during the instantaneous count. Canoe racks on cars parked at ramps were also included in the counts of trailers.

Before and after the count, the clerk interviewed anglers. If anglers agreed to be interviewed, they were asked how long they had been fishing, whether they were finished fishing, and how many trout they had caught. Anglers were asked their state of residency and Tennessee residents were also asked for their county of residence. The clerk recorded the method of fishing being used by each angler. Finally, the clerk measured the total lengths (nearest cm) of any trout harvested.

Mean daily counts were expanded to estimate effort in each stratum (i.e., kind-of-day), then pooled to estimate effort during each two-week period following the methods of Pollock et al. (1994). Average catch and harvest rates were measured using the mean of ratios method, which is recommended for roving creel surveys (Pollock et al. 1997). Catch and harvest rates were calculated for all parties that had been fishing for at least 30 minutes before being interviewed. The catch and harvest of each trout species was then estimated each month. Standard errors of catch, harvest, and effort each month were calculated according to Pollock et al. (1994). A spreadsheet performed all necessary calculations and calculated 90% confidence intervals around each estimate. The pooled variance for total pressure, total harvest, and total catch of each species was calculated using the mean-square-successive-difference-between-periods procedure. The square root of the variance was multiplied by 1.6 to estimate 90% confidence intervals.

## **RESULTS and DISCUSSION**

### **Fishing Pressure**

Fishing pressure over the eight-month survey totaled 48,190 h (90% confidence limits  $\pm 6,282$ ; Table 1); pressure peaked in July (8,640 h). Average trip length was 2.71 h ( $n = 196$  parties;  $SE = 0.11$ ); thus, anglers made an estimated 17,782 trips to the tailwater in the 2002 survey. Over a comparable eight-month period, fishing pressure

was 52% lower in 2002 than in 1997 (100,844 h;  $P < 0.10$ ). Trip length was significantly longer in the 1997 survey (3.47 h; Wilcoxon two-sample test;  $P < 0.0001$ ) and more trips were made to the tailwater during that survey ( $n = 29,028$ ).

During 117 instantaneous counts, the clerk observed only 31 boats (including canoes and rafts with anglers) on the South Fork of the Holston River during the survey period. A concurrent creel survey on the Watauga River observed 424 boats (usually McKenzie-style drift boats or rafts) during 129 instantaneous counts (Bettoli 2003).

On many Tennessee tailwaters, fishing pressure is inversely related to the amount of water discharged from the dam (e.g., Caney Fork River; Devlin and Bettoli 1999) and the same relationship existed for the South Fork of the Holston fishery in 2002 during weekend counts (Table 1), when pressure was always higher on average.

Table 1. Mean number of anglers observed during instantaneous counts on the South Fork of the Holston River, May – October 2002. Counts in March and April were excluded because of too few days with generation beyond minimum flow requirements. All counts were adjusted (see text for explanation). The one-way ANOVA model was significant ( $F=15.60$ ;  $df = 3,87$ ;  $P = 0.0001$ ). Means sharing the same letter were declared similar (LSD test;  $P = 0.05$ ). Discharge refers to the river stage at the beginning of each count.

Kind-of-Day	Discharge	Mean	N	Standard Error
Weekday	Minimum Flow	11.7 <sup>B</sup>	24	1.58
Weekday	Generation	9.5 <sup>B</sup>	32	1.22
Weekend	Minimum Flow	29.4 <sup>A</sup>	24	3.86
Weekend	Generation	11.1 <sup>B</sup>	11	2.60

The inverse relationship between discharge and fishing pressure cannot explain the decline in fishing pressure since 1997 because discharges were higher in 1997 (Table 2).

Table 2. Average daily discharge (cfs) from South Holston Dam, March – October.

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002
Discharge	1,108	801	1,006	1,090	1,555	614	770	837	687

## **Catch and Harvest**

Anglers reported high catch rates throughout the survey. The pooled catch rate (both trout species; all parties fishing more than 30 minutes) averaged 1.71 trout/h (SE = 0.09; n = 834), which was 54% higher than the pooled catch rate in 1997 (1.11 trout/h;  $P < 0.0001$ ; Wilcoxon two-sample test). The pooled harvest rates in 1997 and 2002 were significantly different (0.35 and 0.32 trout/h, respectively;  $P < 0.0001$ ); however, the slight decrease in 2002 was small and can be ignored given the huge sample size ( $n_{\text{total}} = 2,738$  parties) and resultant high statistical power.

Over the entire survey, the estimated catch of rainbow trout was 66,800 fish, of which 15,627 were harvested (Table 1). The difference between the number of rainbow trout harvested and the number caught represented a release rate of almost 77%. Anglers reported catching an estimated 13,565 brown trout and harvesting only 1,031 fish, yielding a release rate of 92%. Catch data in the 1997 survey were not recorded separately for each species; the total estimated catch in 1997 was 118,670 trout, or 48% higher than the combined catch in 2002 (80,365 rainbow trout and brown trout). The number of rainbow trout and brown trout caught and harvested (separately) each month in the 2002 survey was positively related to fishing pressure ( $r \geq 0.64$ ;  $P \leq 0.08$ ).

The clerk measured 709 rainbow trout that anglers harvested (Figure 1). Eighteen percent were longer than 305 mm (12 inches) and only one was in the protected slot (i.e., an illegal fish). That one illegal rainbow trout was 46 cm long (18.1 inches). Sixty-nine brown trout were observed in the creel and 28% were longer than 305 mm (Figure 1). The largest brown trout in the creel was 56.5 cm long (22.2 inches). Ninety-one percent of the rainbow trout and brown trout measured by the clerk were observed between the dam and the ramp just below Emmett Bridge.

The mean number of trout harvested by complete-trip anglers was 0.81 fish per angler per trip (n = 193 complete-trip parties; Figure 2). Twenty-six percent of complete-trip parties were observed harvesting trout; none were observed with more than the legal creel limit of 7 trout per angler per day. Although harvest rates were low, catch rates averaged 5.88 fish per angler per trip (Figure 2). About 20% of complete-trip parties failed to catch a fish.



### **Angler Characteristics**

Sixty-three percent of the 1,443 anglers interviewed on the South Fork of the Holston River in 2002 were Tennessee residents (Figure 3), which was lower than the 70% Tennessee residency rate observed in the 1997 creel survey. Most out-of-state anglers were Virginia residents (28% of all anglers). North Carolina residents represented 5% of all anglers interviewed, and the remainder came from 14 other states. Residents of Sullivan County, which wholly encompasses the river, accounted for 54% of all the anglers interviewed and 84% of the Tennessee resident who fished the river. Residents of nearby Washington County represented 6% of all anglers interviewed and 10% of all Tennessee residents. In 1997, 62% of the anglers interviewed by TVA were fishing with some form of bait; that percentage rose to 74% in 2002.

### **CONCLUSIONS**

In the late 1990s, the South Fork of the Holston River tailwater was the most heavily fished tailwater in Tennessee. In the 2002 survey period, fishing pressure declined more than 50% compared to 1997. No empirical data exist to explain the substantial drop in fishing pressure on the South Fork of the Holston River in 2002 compared to the 1997 survey, nor the concomitant increase in pressure on the nearby Watauga River (Bettoli 2003). Possible explanations for why fishing pressure increased on the Watauga and decreased on the South Fork of the Holston Rivers would include the following:

- (1) There is more developed access (i.e., for trailered boats and rafts) and more undeveloped access on the Watauga River;
- (2) The Watauga River is easier to float at any level of generation; the South Fork of the Holston River cannot be floated at minimum flow.
- (3) There are no campsites on the South Fork of the Holston River, but two on the Watauga River;

Items 1 and 2 might explain some of the increase in guided and unguided fishing activity using boats and rafts on the Watauga River in 2002, and the paucity of boat anglers on the South Fork of the Holston River. The differential ability of each fishery to support float trips (in terms of water levels) has not changed since each river was surveyed in the 1990s, but access has improved since 1997 on the Watauga River. Bettoli (2003) noted that the opening of one private campground with a ramp on the Watauga River accounted for roughly 25% of all the pressure that the river received in 2002. No data are available to determine whether the protected slot limit on the South Fork of the Holston River (enacted since the 1997 survey) had any influence on angler behavior or visitation rates in 2002 (the “No Fishing” spawning refuges are only in effect seasonally and would not have had any effect on fishing pressure during the March-October creel survey period). Similarly, no data exist to determine whether the publicity and extra trout stockings the Watauga River received after the catastrophic fire and fish kill in 2000 played any role in attracting anglers to the Watauga River, and whether those anglers used to visit the South Fork of the Holston River.

The South Fork of the Holston River remains a premier Tennessee trout fishery based on its production of wild trout (Bettoli et al. 1999) and the size and number of trout inhabiting the system (Habera et al. 2003). Future creel surveys will reveal whether the drop in pressure the South Fork of the Holston River experienced in 2002 was an anomaly. Survey instruments can also be developed to determine what motivates anglers to choose to fish either the Watauga or the South Fork of the Holston River, and whether those motivations have changed in recent years. Such information would be valuable if the goal of managers is to increase visitation rates to either or both fisheries.

## **ACKNOWLEDGMENTS**

This research was supported by a grant from the Tennessee Wildlife Resources Agency. Additional matching funds were provided by the Tennessee Cooperative Fishery Research Unit and the Center for the Management, Utilization, and Protection of Water Resources, Tennessee Technological University. The results reported herein could not have been obtained without the conscientious efforts and dedication of the creel clerk for this survey, Michelle Brown, who performed her duties with style and grace. The author appreciates the insights into angler behavior offered by the clerk for the Watauga River Creel Survey in 2002, Michael Widener. The discharge data for South Holston Dam reported herein was graciously and promptly provided by Julia Warren, Tennessee Valley Authority. This report benefited from constructive comments provided by Rick Bivens, Bart Carter, Jim Habera, and Frank Fiss.

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Table 3. Fishing pressure and number of rainbow trout and brown trout caught and harvested by anglers fishing the South Fork of the Holston River, March - October 2002. Mean catch-per-unit-effort rates based on interviews of parties that had been fishing at least 30 minutes.

Month	Pressure (hours)	SE	Rainbows Caught	SE	Rainbows Harvested	SE	Browns Caught	SE	Browns Harvested	SE	Mean CPUE
March	5,556	1,524	7,197	3,791	1,304	450	999	367	101	56	1.62
April	6,938	1,091	8,307	1,736	1,665	403	1,578	539	234	157	1.43
May	7,233	1,229	8,800	1,633	1,739	372	4,377	911	93	56	2.29
June	6,954	809	10,984	2,131	2,377	433	2,221	571	98	41	1.81
July	8,640	1,975	16,850	5,748	5,011	2,903	1,949	648	263	178	2.03
August	5,672	1,261	5,135	1,158	701	336	1,119	261	101	64	1.18
September	4,157	901	6,335	1,976	1,749	683	798	304	48	34	1.66
October	3,040	489	3,192	741	1,081	373	524	111	93	36	1.19
TOTAL	48,190	3,141	66,800	10,398	15,627	3,971	13,565	2,804	1,031	101	1.71

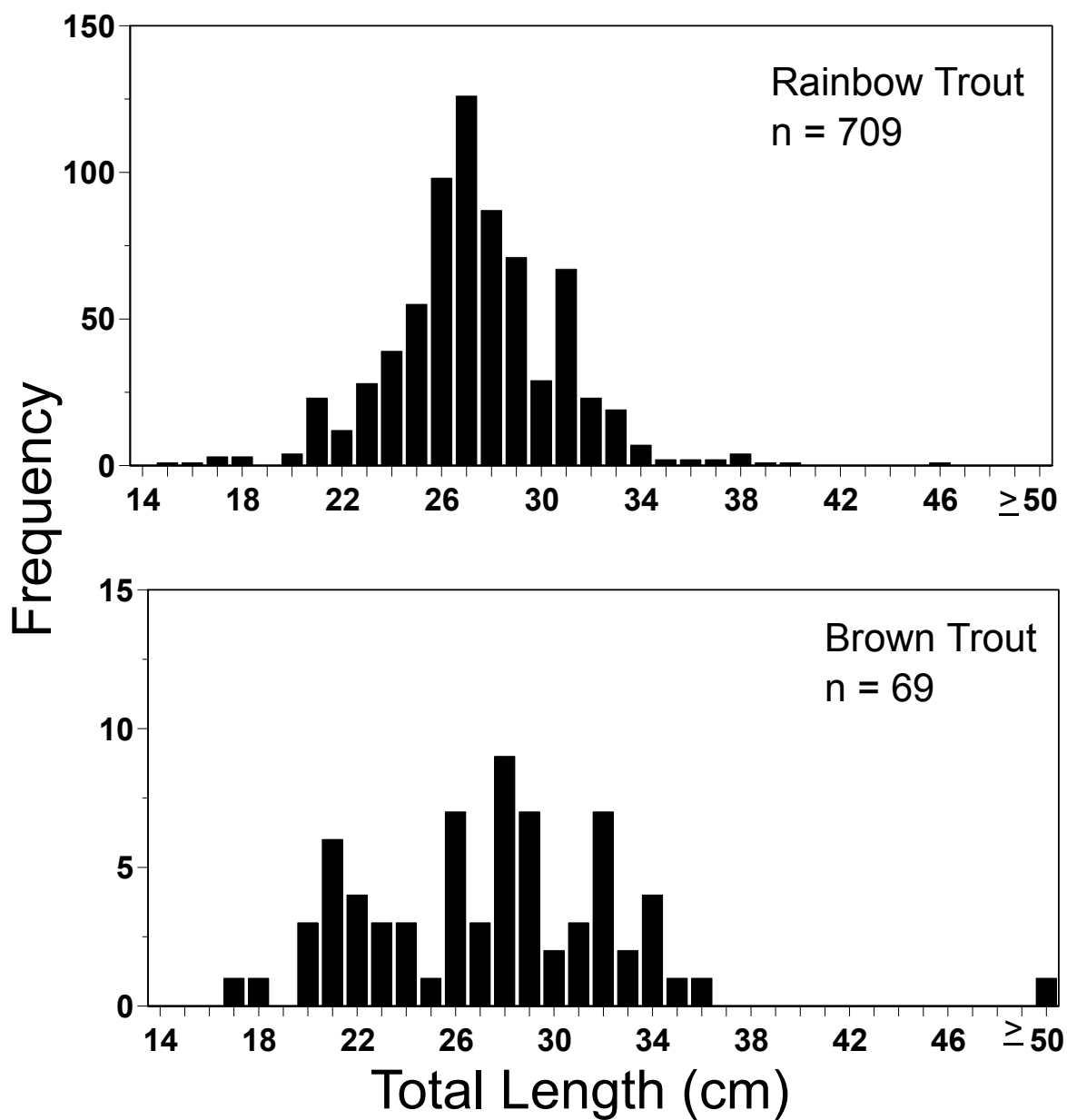


Figure 1. Length-frequency distributions for trout observed in the creel of anglers in the South Fork of the Holston River, March - October 2002.

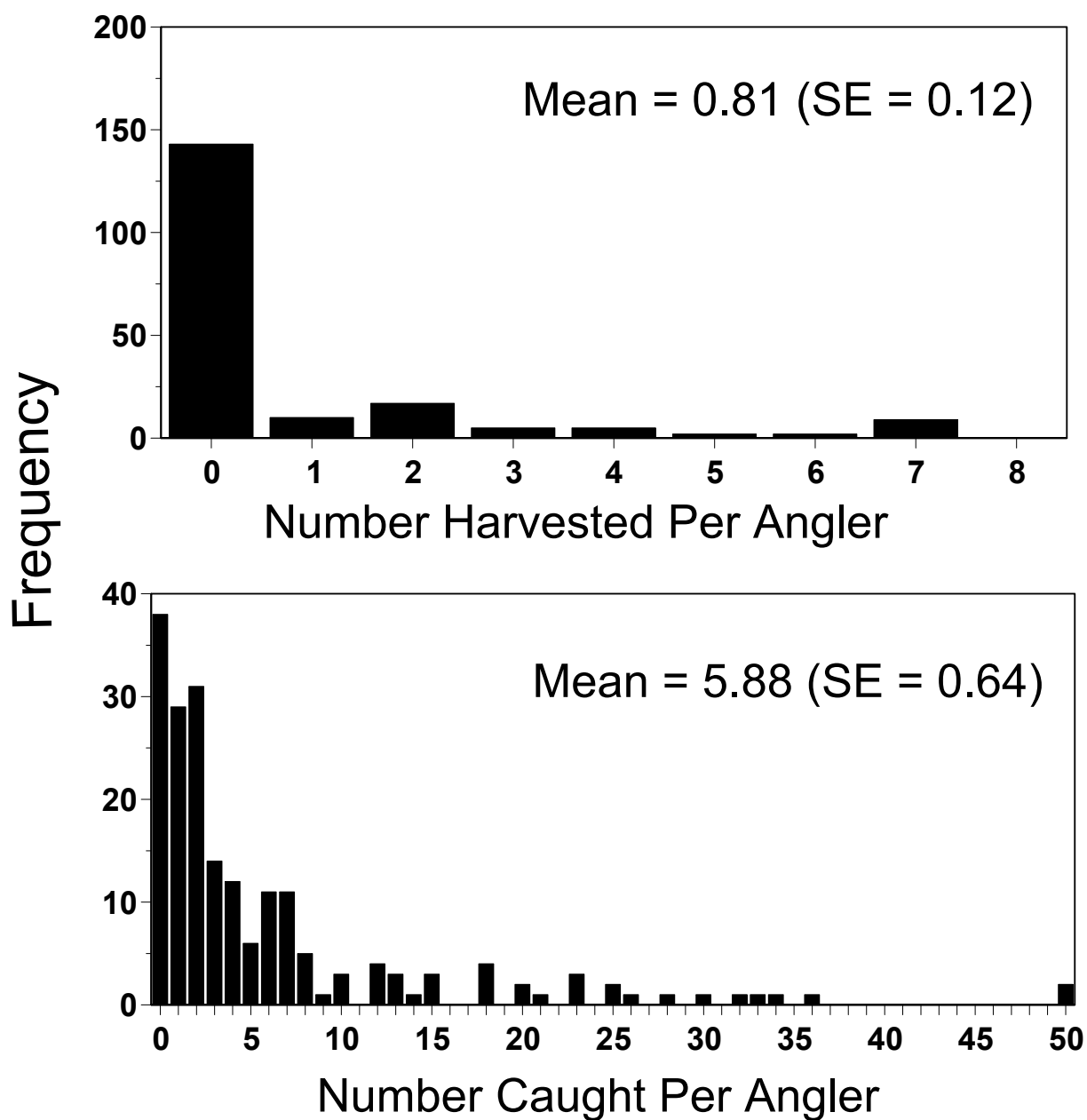


Figure 2. Frequency distribution for the average number of trout harvested and caught by each member of parties that had completed fishing when interviewed on the South Fork of the Holston River, March - October 2002. N = 193 parties.

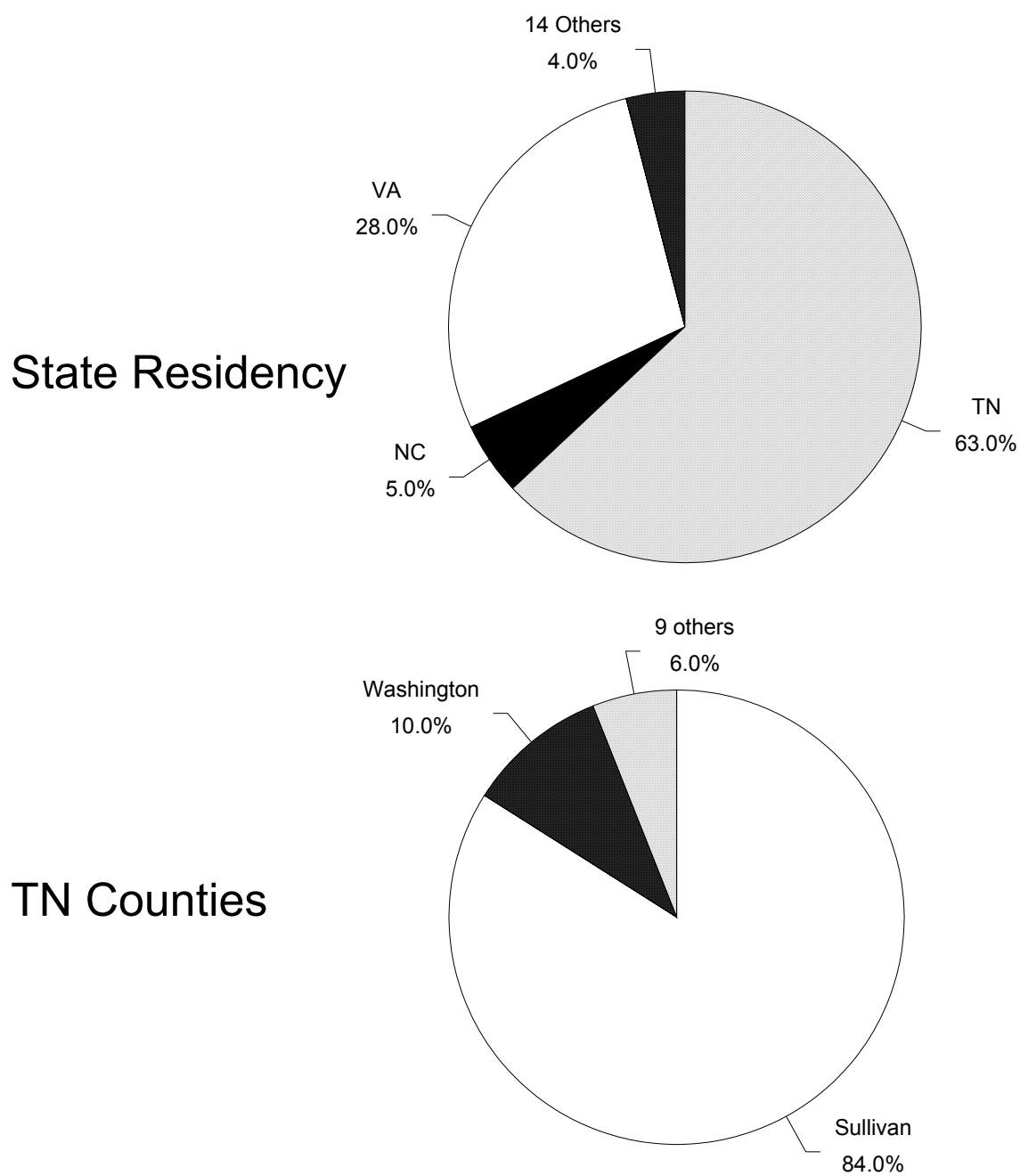


Figure 3. State residency and Tennessee county residency for anglers interviewed on the South Fork of the Holston River, March - October 2002.



## **APPENDIX**

Survey forms used during the creel survey on the South Fork  
of the Holston River, 2002

**DAILY SAMPLE SHEET – SF HOLSTON 2002**

DATE (mm/dd/yy) \_\_\_\_\_ KIND OF DAY \_\_\_\_\_  
 01 = weekday 02 = weekend or holiday

TIME COUNT BEGAN \_\_\_\_\_  
 (military time)

RIVER STAGE WHEN COUNT BEGAN \_\_\_\_\_  
 (0 = no generation 1 = generation)

Access Point	ANGLERS	BOATS	TRAILERS OR OR CARTOP CARRIERS
1. Above Labyrinth Weir			
2. Below Labyrinth Weir			
3. Hickory Tree Bridge / Rivers Way			
4. River Road			
5. Webb & Weaver Pike Bridges			
6. Rockhold Church Reach			

**T O T A L S**

Anglers	Boats	Trailers/Carriers

ADJUSTED ANGLER COUNT (leave blank) \_\_\_\_\_

End Mileage = \_\_\_\_\_

Beginning Mileage = \_\_\_\_\_

Clerk \_\_\_\_\_  
 Total Mileage = \_\_\_\_\_

NOTE: Canoes, drift boats, rafts and johnboats all count as "boats". Don't count float tubes

# INTERVIEW SHEET - HOLSTON RIVER 2002

DATE (mm/dd) \_\_\_\_\_ INTERVIEW NUMBER \_\_\_\_\_

KIND-OF-DAY \_\_\_\_\_ ACCESS POINT (1 - 6) \_\_\_\_\_  
 Weekday = 1 Weekend / holiday = 2 (River reach)

NUMBER IN PARTY \_\_\_\_\_

START OF FISHING \_\_\_\_\_ END OF FISHING \_\_\_\_\_  
 (MILITARY TIME) (or time of interview) (MILITARY TIME)

Time Fishing \_\_\_\_\_  
 By Party \_\_\_\_\_  
 Hours minutes

COMPLETED TRIP ? \_\_\_\_\_ SPECIES FISHED FOR \_\_\_\_\_  
 Yes = 1 No = 2 Trout = 1; Any/Other = 2

Number of **Rainbows CAUGHT** = \_\_\_\_\_ Number of **Rainbows KEPT** = \_\_\_\_\_

Total Lengths of Rainbows Kept (nearest cm): \_\_\_\_\_

Number of **Browns CAUGHT** = \_\_\_\_\_ Number of **Browns KEPT** = \_\_\_\_\_

Total Lengths of Browns Kept (nearest cm): \_\_\_\_\_

For METHOD, TERMINAL GEAR, and LOCATION, the numbers entered in each line should equal the number in the party. Use fractions if an angler used multiple methods..

METHOD → STILLFISHING \_\_\_\_\_ SPINFISHING \_\_\_\_\_ FLYFISHING \_\_\_\_\_

TERMINAL GEAR → ARTIFICIAL LURES or FLIES \_\_\_\_\_ BAIT \_\_\_\_\_

LOCATION → BOAT \_\_\_\_\_ OTHER \_\_\_\_\_